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PRECIPITATION IN THE NORTHERN GREAT PLAINS

By W. A. MATTICE

[Weather Bureau, Washington, January 1935]

Abnormalities in weather focus public interest on localities that may be experiencing unusual extremes. Thus, a report of extremely cold or hot weather in the newspapers at once arouses temporary interest in the place mentioned. Also, but to a more limited extent, local droughts are of interest, while floods occupy much space on the front page. Droughts usually are not so intensive in interest as floods, but the severe dry spells that were experienced in 1930 and again in 1934 were of such magnitude as to create wide-spread concern. The region covered in this paper has been the focal point of the droughts in recent years, as the precipitation in many places therein has been scanty for a comparatively long time.

Wide-spread interest has prompted this paper. The charts partially fill the need for detailed climatic maps of the area concerned. The data on which they are based are contained largely in Bulletin W, of the Weather Bureau.

Much comment has been heard in recent years about the suitability of our dryer regions for agriculture, and much of the Northwestern Plains has been classed as only semiproductive or submarginal. So far as temperature is concerned, many staple crops could be grown with profit in this section by selecting those with the proper thermal requirements, but the agricultural utilization of much of this land is limited by moisture conditions.

For ordinary agriculture the average annual precipitation is considered the limiting factor for general farming. However, the average or normal rainfall does not mean that this amount can be expected in 50 percent of the years, as it is generally well known that a greater proportion of the years have rainfall below normal.

Chart I shows the average annual precipitation for the northern Great Plains. In the preparation of this and other charts, the method of Kincer (1) was followed in locating the isohyetal lines. The average annual amounts range from around 25 inches, or slightly more, in southeastern South Dakota to less than 10 inches in parts of Wyoming and Montana. The annual rainfall decreases progressively westward, the region varying from semihumid in eastern South Dakota to almost arid in parts of Wyoming. The higher elevations of Montana and Wyoming are relatively well supplied with moisture, with the average annual precipitation over 30 inches in extreme western Montana and over 25 inches in north-central and northwestern Wyoming. On the other hand, parts of these States have less than 10 inches of rain a year, on the average, notably in the upper Red Rock Valley of Montana and in the lower Shoshone and Bighorn Valleys of Wyoming.

One important feature of this map is the large area with annual rainfall less than 15 inches. As the isohyetal lines are drawn to 2-inch intervals on the even numbers, some interpolation is necessary, but the size of the region can be readily determined. A large section of northwestern North Dakota has, on the average, less than 16 inches a year, while much of eastern and northern Montana has less than 14 inches. As the minimum amount of annual precipitation necessary for successful farming by ordinary methods usually is considered to be between 15 and 20 inches, this region is especially noteworthy. With an annual rainfall of less than 15 inches, other conditions must be very favorable to ensure successful farming in the long run.

In the Great Plains the agricultural significance of the rainfall depends principally on its seasonal distribution, the variations of amount from year to year, or its dependability, and the rate of evaporation. All of these modifying factors operate more favorably in the northern part than in other sections of the Plains, with the result that while rainfall is scantier in the north, conditions there are climatically more favorable for crop growth than elsewhere in the area where the average annual precipitation may be comparable.

In the Great Plains it is the rainfall of the crop growing season that is important from the agricultural viewpoint. The winter precipitation is light and the amount stored in the soil at the beginning of spring usually is small. Normally the rainfall increases rapidly with the advent of spring; May and June commonly are the months of greatest amounts. The warm-season rains comprise much the greater proportion of the annual, except in some districts of Montana.

Chart II shows the average warm season precipitation. This chart covers the months from April to September, inclusive. The amounts vary from around 20 inches in extreme southeastern South Dakota to less than 6 inches in north-central Wyoming. Much of South Dakota has more than 12 inches during this 6 months' period, while the eastern part of the State averages over 14 inches. In North Dakota the average amounts range from 11 to over 16 inches, but in Montana and Wyoming the topography has such a large effect that no definite extensive area can be delimited, except for eastern and northern Montana where the warm-season rainfall averages from 10 to 11 inches.

Chart III shows the percent of the annual precipitation that occurs during the warm season. It will be seen that much of the Dakotas average more than 75 percent of the year's rainfall during the 6 warm months; some sections average over 80 percent, and limited localities range as high as 84 to 92 percent. In Montana the percentages vary widely, from 80 in parts of the east and north to less than 40 in the western valleys. Wyoming has much the same characteristics as Montana, with the percentages ranging from 40 to nearly 80. As indicated on this chart, the annual rainfall may be small, but the seasonal distribution is very favorable in making much the greater part of the total available for crop growth.

A very important matter in connection with this region is that of droughts. How frequently do they occur and how severe and long-continued are they? The answer to the first question is indicated by chart IV, which shows for a 40-year period, 1894–1933, the percentage of the years with less than 15 inches of precipitation. The minimum amount is very important, and agricultural planning should be made in expectation of recurring droughty periods. The chart shows that the percentage of years with less than 15 inches of precipitation ranges from around 4 in southeastern South Dakota to 80 or even up to 100 in parts of northern Wyoming. Most of Montana east of the Continental

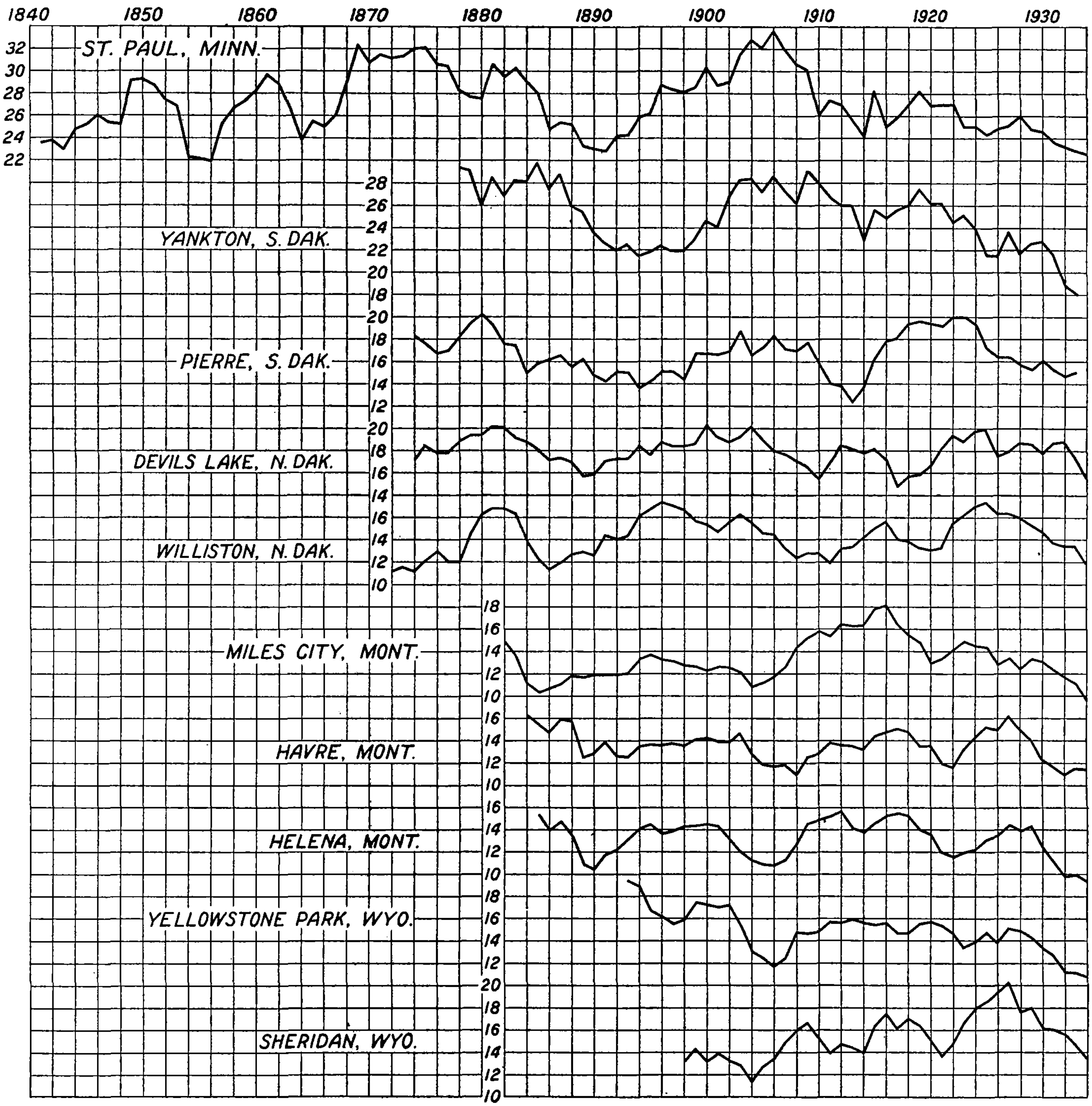
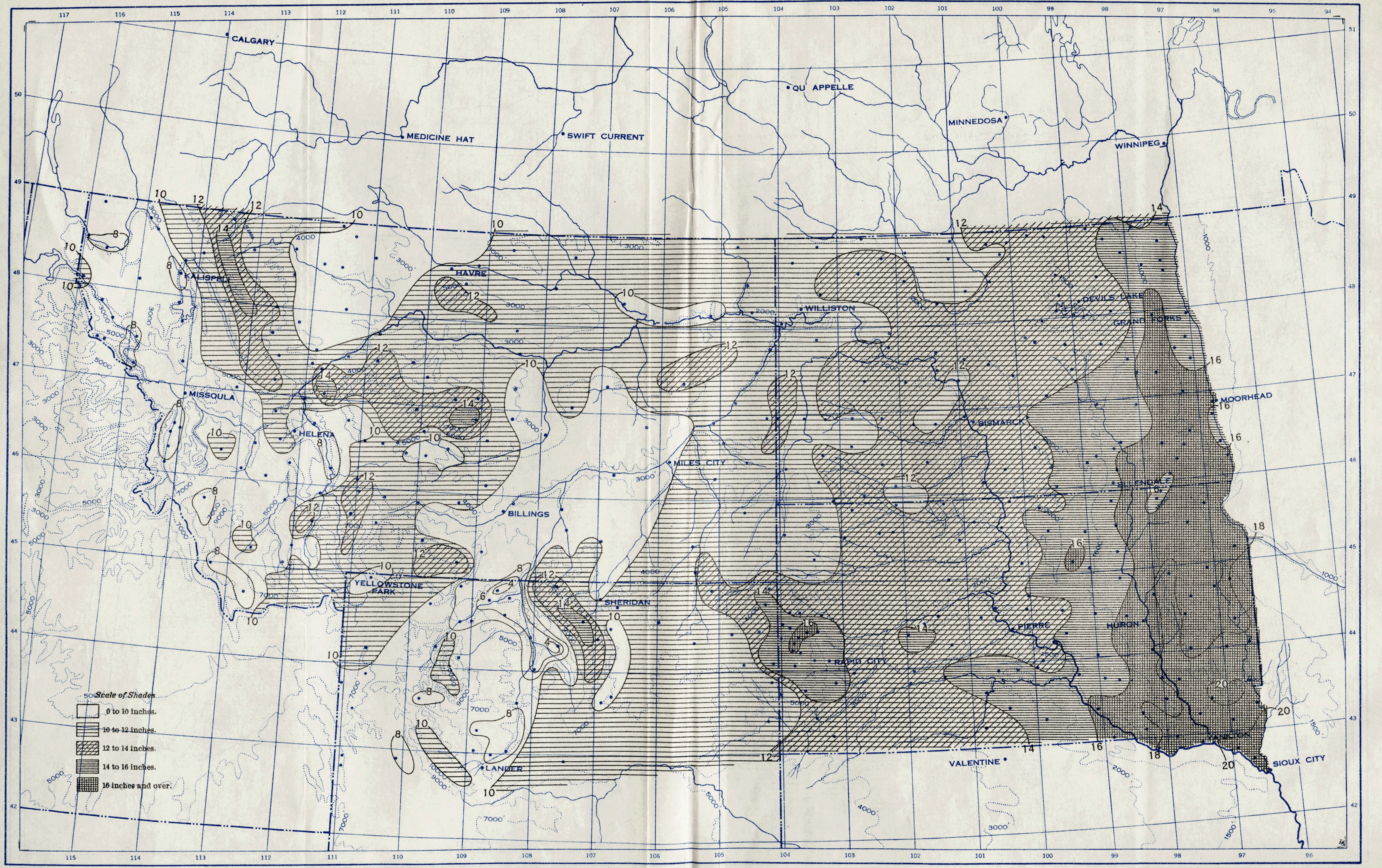


FIGURE 1.—Average annual precipitation by 5-year moving averages for selected stations in the northern Great Plains.

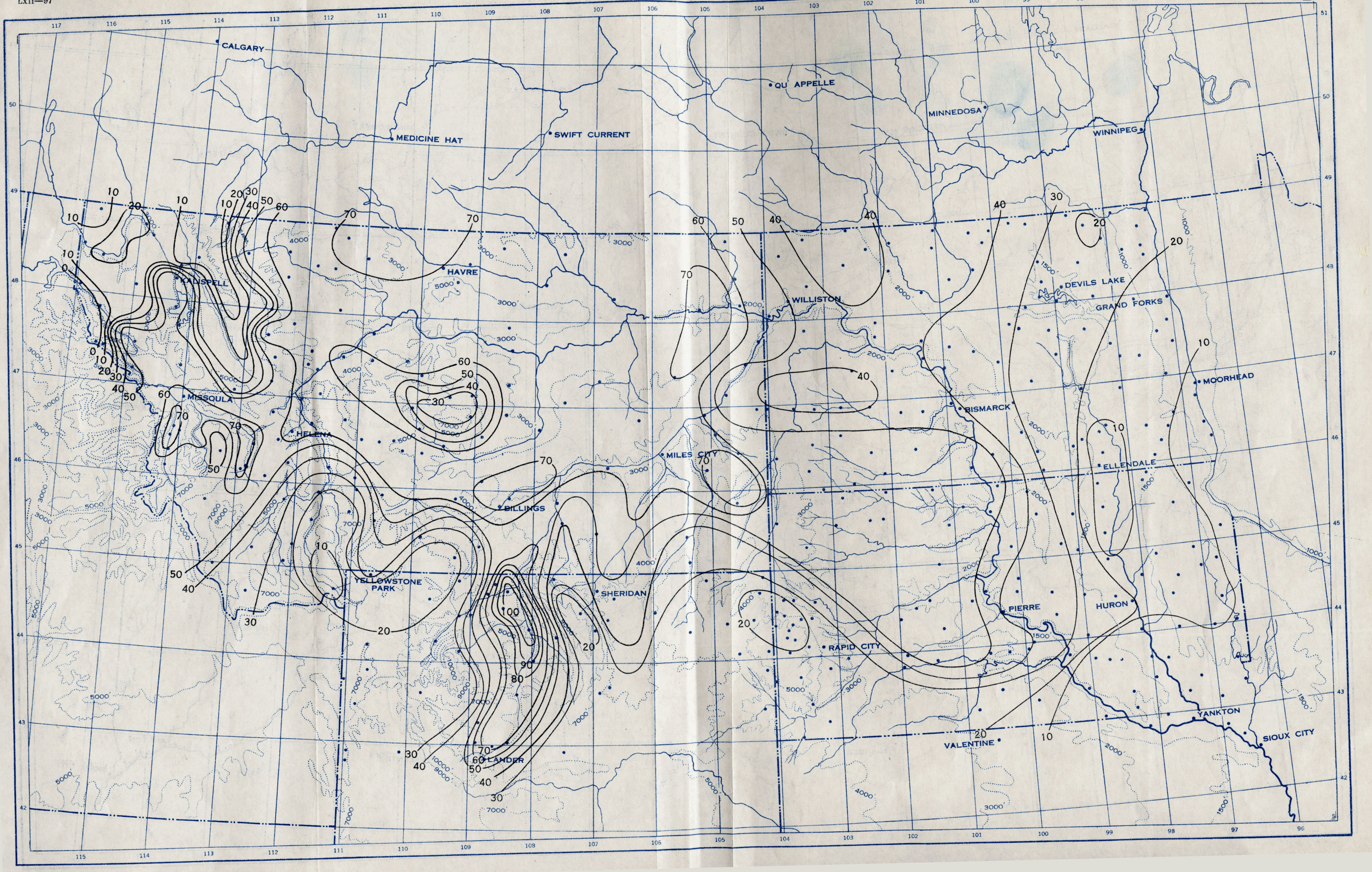
Fig. 1. Average Annual Precipitation for the Northern Great Plains

W. A. M. **Fig. 2. Average Warm-Season precipitation (April-September), for the Northern Great Plains**



W. A. M. **Fig. 3. Percentage of the Annual Precipitation that Occurs During the Warm Season (April-September).**

W. A. M. **Fig. 4.** Percentage of Years with Less than 15 Inches of Precipitation (40 Years' Record, 1894-1933)



Divide may expect an annual rainfall of less than 15 inches in over half the years, although some western localities very rarely have less than this. In North and South Dakota the percentages drop off rapidly to the eastward, ranging from around 40 to 50 in the western parts to mostly less than 10 along the eastern borders.

Figure 1 has a bearing on the question of duration and intensity of droughts. The data shown are annual precipitation by 5-year moving averages; that is, each point on the graphs represents the average for the 5 years up to and including that year. The long-record graph for St. Paul, Minn., is included for comparison with the shorter periods of the stations in the area concerned. Some of these necessarily are combinations of records for nearby stations in order to obtain as long a period as possible. Thus, the data for Williston, N. Dak., represent not only those for Williston, but also those for Buford, N. Dak., a nearby station with an earlier record than is available at Williston.

Similarly the record for Pierre, S. Dak., is combined with a record for Fort Sully, S. Dak., also a nearby station with earlier data. While all of the data are not strictly homogeneous they show the general tendency of precipitation in this area.

The record for St. Paul covers the years 1836–1934, inclusive, while the others are shorter. The sparse settlement of much of this area in the earlier years prevented complete coverage, and it was extremely difficult to maintain continuity of records.

The really encouraging indications of these graphs are the recoveries that were made after previous depressions rather similar to that now prevailing. The trends for Yankton, S. Dak., follow those for St. Paul closely, but in general the stations tend to less variation as they progress westward. Miles City, Mont., shows a long-time drop in annual rainfall similar to St. Paul, but most of the other stations show general tendencies to dryness only during the last few years; for instance, for Williston, N. Dak., the annual trend has just started down, indicating that perhaps this region is tending toward a series of dry years.

The most important feature in all these graphs is the fact that for every series of years with subnormal rainfall there is a subsequent recovery with above-normal amounts for several years. The periods are far from uniform in length, as is readily apparent, but the most striking thing is the alternation of depressions and recoveries just mentioned.

Grateful acknowledgment is made of the invaluable aid and advice freely given by Mr. J. B. Kincer. Acknowledgment is also made of the material that was taken from Kincer's article on the climate of the Great Plains (**2**).

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METEOROLOGICAL EXTREMES OF THE SOUTHWEST

By CLARENCE E. KOEPPE [1]

[Southwest Missouri State Teachers College, Springfield, August 1934]

The average person remembers the unusual weather which he has experienced, and forgets the normal course; and of this unusual weather, he is likely to remember only that which occurred most recently or which may have made some deep impression upon him at the time. If, as a child, he had an unusual experience of wading through snow up to his hips on Thanksgiving Day, that fact clings to his mind for years; and because no other Thanksgiving since then may have had snow that deep, he knows that the weather isn't what it used to be, notwithstanding that snow, hip deep, to a child might not need to be much more than a foot deep. It may seem, therefore, that the subject here treated would only be aggravating a situation already bad. That can hardly be the case, however, because probably no reader of this article has experienced as much as 5 percent of the phenomena or conditions which are portrayed. To the student of human climatology a knowledge of extremes of weather is quite as significant as a knowledge of averages, since the extremes cause so much property loss and human suffering. The extremes noted here do not in any sense comprise all those observed in the Southwest over even a recent period, for only a small percentage ever find their way into print; and necessarily the source of information herein contained is almost wholly from published records.

Temperature extremes seem to interest the greatest number of individuals, for there is no one who is not affected directly by them unless he should be so fortunate as to be able to seek a more congenial clime when temperature extremes are greatest, namely, in summer or in winter. The person living in a substantial city apartment is less directly affected by drouths and floods, snow and rain, wind and hail, than by temperature.

The most pronounced extremes of temperature seem to be in Colorado, at elevations between 5,000 and 10,000 feet. Pagosa Springs, in the southwest portion of the State, has an absolute range of temperature of 156°, from 95° in July to 61° below zero in February, which was attained during the cold wave of 1933 (**1**). During that same cold wave, the temperature at Silverton, in western Colorado, dropped to 56° below zero, giving it an absolute range of 149°. Of course, large ranges of temperature are experienced elsewhere than on the Colorado plateaus; Warsaw, Mo., for instance, with an elevation of only 715 feet, has an absolute range of 151°, from 115° in July to −36° in February.

Of all of the southwest portion of the United States, least absolute ranges of temperature are found in southern Texas and Louisiana. The smallest range is 80° at Bay City, Tex., where the highest temperature recorded was 98° in both July and September and 18° in January. San Benito, in southwestern Texas, has an absolute range of 82°, while Louisiana's smallest absolute range is found at Carrollton, 83°. During a 50-year period, the highest temperature recorded in Palestine, Tex., was 108° in August, while that at Port Arthur, Tex., was 102° in June; Palestine's minimum, however, is 6° below zero for February, and that of Port Arthur is but 11° for January. Gulf waters presumably cause these differences.

Even places on the Gulf have their cold waves. At Galveston, Tex., in February 1899, the temperature dropped to 7.5°, causing fish which were caught in shallow warm water to die from chill before reaching deep water

[1] Actively assisted by Mary Botts, Helen McBride, and William Raney, research students. In many instances, new records for drouth and high temperature were established during the summer of 1934.